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## SOME RADIOLOGICAL ASPECTS OF CANCER OF THE COLON\*—Part II

ARTHUR C. SINGLETON, M.D., F.R.C.P., (C), F.F.R.

Toronto, Ontario

I have chosen the subject of "Some Radiological Aspects of Cancer of the Colon" for this lecture because of the improving outlook for patients with cancer of the colon if their disease is diagnosed early and because of the fact that early diagnosis is mainly radiological. I would like to present some opinions on methods of examination and to discuss polypoid lesions, some of which are cancer, some of which may be related to cancer of the colon and some from which cancer must be differentiated.

In the Province of Ontario in 1950, of a population of four and a half million people, 802 died of cancer of the large intestine exclusive of the rectum; 365 were men and 437 were women. The maximum age incidence was from sixty to eighty, though it is interesting to note that 21 deaths occurred under the age of forty. In the same year reported deaths from cancer of the rectum numbered 341, 227 men and 114 women. It is noted from these statistics that cancer of the colon is a more common cause of death than cancer of the rectum, that colonic cancer is more common in women than in men and that rectal cancer is more common in men than in women<sup>28</sup>.

Reviews of the literature of cancer of the colon over the past twenty years, such as that by Rankin and Graham, show an increasing percentage of cases which are operable with hope of cure, a lowering of operative mortality and an increase in percentage of five-year survivals. The mortality rate is higher in cases with obstruction than in those without obstruction; the objective therefore must be to find these cases at an earlier stage and before the onset of obstruction. This can be accom-

plished only by education of the public, not only that rectal bleeding or change in bowel habit may mean cancer of the bowel, but also that cancer of the bowel is not always a hopeless disease but that many cases are cured by early proper treatment. Along with education of the public we must be constantly aware of our responsibility as physicians to investigate properly every such patient referred to us. Every case of persistent or recurrent change in bowel habit and every case of rectal bleeding must be thoroughly investigated as soon as the patient reports these symptoms or signs to his or her physician.

The explanation of haemorrhage on the basis of haemorrhoids and the failure of the referring doctor to do even a rectal examination are still common causes of late diagnosis of cancer of the rectum. We have always maintained that the radiologist should not be held responsible for the diagnosis of cancer of the rectum, though radiological evidence is often of value in these cases in determining the limits of the disease, in the planning of surgical treatment. Carcinoma and polyps are of common occurrence in the rectum and lower sigmoid and this region presents considerable difficulty of radiological visualization in many cases.

In a series of 156 cases of polypoid colonic disease Swinton and Warren<sup>36</sup> found 70% of these lesions to be in the rectum or lower sigmoid. Coffey and Bargen<sup>4</sup> found over 51% of polyps limited to the rectum. Weber<sup>39</sup> found approximately 50% of cancers and of polyps of the large bowel to be in the rectum. The complementary role of sigmoidoscopic and radiological examinations in disease of the large bowel is therefore obvious and this cannot be over-emphasized. All patients who are passing bright blood by bowel should be sigmoidoscoped preferably prior to radiological investigation by barium enema. The expla-

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nation of rectal bleeding on the basis of haemorrhoids should be tenable only after exclusion of a more serious cause of the haemorrhage by sigmoidoscopic examination or barium enema or both.

Carcinoma of the colon occurs as a multiple disease in a small number of cases, so that the finding of one carcinoma should not exclude the possibility of a second one being present in another segment of the bowel. Swinton and Haug<sup>25</sup> in a series of autopsies found 208 carcinomas of the bowel in 195 individuals. Approximately 6% of their cases of cancer of the colon had multiple cancers. A recent remarkable case of multiple cancers of the colon is reported by Marshak<sup>23</sup>, whose patient, a 42-year-old woman, had 5 apparently primary carcinomas at one time, one in the ascending colon, one in the transverse, two in the descending and one in the sigmoid colon.

There is some evidence to suggest that the patient who has had one carcinoma successfully treated may be more likely to develop a second cancer than the person who has not had one. We recently have found the third colonic carcinoma in a woman of 55. (Case 1—Fig. 1.)



**Case 1. Fig. 1.**

**Mrs. L.T.S. Age 55 — Carcinoma of the Caecum.**

This patient had a carcinoma of the descending colon removed in 1938 by Mikulicz type of operation. In 1946 she developed a carcinoma at the splenic flexure which was removed and primary anastomosis done. Prior to the present examination in September, 1952, she complained of feeling weak

and tired easily. She went to her physician for a blood examination. She had no disturbance of bowel function and had not passed visible blood by bowel. Her haemoglobin was found to be 65% and in view of her previous history she was referred for colon examination. This revealed the large carcinoma of the caecum low in the pelvis without palpable abdominal mass. This carcinoma has since been removed. There were no demonstrable metastases and she has made an uneventful recovery. The appearance of the descending colon is due to the previous Mikulicz type of operation performed for her first carcinoma.

#### Methods of Examination, Technique and Preparation

It is not necessary here to go into the detail of the standard methods of examining the colon. The barium sulphate enema in use for so many years and the refinement of post-evacuation examination introduced by Lust and Jacobi<sup>20, 21</sup> in 1936 is now accepted practice. The double-contrast examination of barium and air, introduced by Fischer<sup>7</sup> in 1923 and developed on this continent by Weber<sup>28</sup> and Gershon-Cohen<sup>10</sup>, has become a common procedure in the investigation of cases of rectal bleeding and in the search for small lesions of the colon. (Fig. 2-C.) That double-contrast enema is a great advance over plain enema and post-evacuation films is freely admitted. It is, however, a painstaking and time-consuming examination. It is dependent upon obtaining exactly the proper amounts of barium and air in every part of the large bowel and upon having loops or flexures free from overlap. We have been very pleased with this method where we have demonstrated a lesion not shown by standard methods, but we have not felt secure in excluding a small lesion where none is visualized. There is still need for improvement in radiological investigation of the colon and a number of newer techniques are available and useful as adjuncts to the regular barium enema.

It has been repeatedly stated, but will bear stating again, that adequate preparation for radiological examination of the colon is one of the most important parts of that examination. A clean bowel not only allows visualization of the colonic wall but also aids the patient in co-operating with the radiologist, as local spasm and cramps are an uncommon accompaniment of barium enema if proper preparation is obtained. We have used one ounce of castor oil the night before routine barium enema for many years but for the past two years we have also been restricting the patient's diet to clear fluids from noon the day before. Castor oil, of course, is not used in cases with obstruction or massive haemorrhage. If a good free purge is not obtained from the castor oil a simple enema taken at least two hours prior to the barium enema

usually results in good cleansing of the colon. Even with this preparation the results are not always perfect and small flecks of fecal matter are occasionally seen in the filled-colon films. These small residues seldom cause confusion, as they usually change position between the antero-posterior and postero-anterior films and are changed in position or are absent at the post-evacuation examination. If the patient does not obtain a good clearing of the colon by the preparation outlined above, the first barium enema may be used as a cleansing enema.

As well as the need for good preparation there is, we feel, room for improvement in technique of enema films. All too often one sees films of a colon showing a chalk-white outline of the bowel in which only the borders of the shadow can be studied, and post-evacuation films in which large amounts of barium are still present in the bowel. It is impossible in many such examinations to exclude even a moderate-sized lesion. In all cases the anterior and posterior walls of the bowel as well as its borders should be seen in filled-colon films and the entire mucosa from terminal ileum to recto-sigmoid juncture should be visualized in the post-evacuation films. Procedures which will provide this have been described in detail elsewhere<sup>32</sup> and will be referred to only briefly here. Visualization of anterior and posterior walls of the filled colon may be obtained by using thinner than average barium

suspension and heavy-penetration technique as advocated by Gianturco<sup>11, 12</sup>, who uses 20% barium by volume in his enema suspensions. He obtained heavy-penetrated films at 100



Case 2. Fig. 2B.

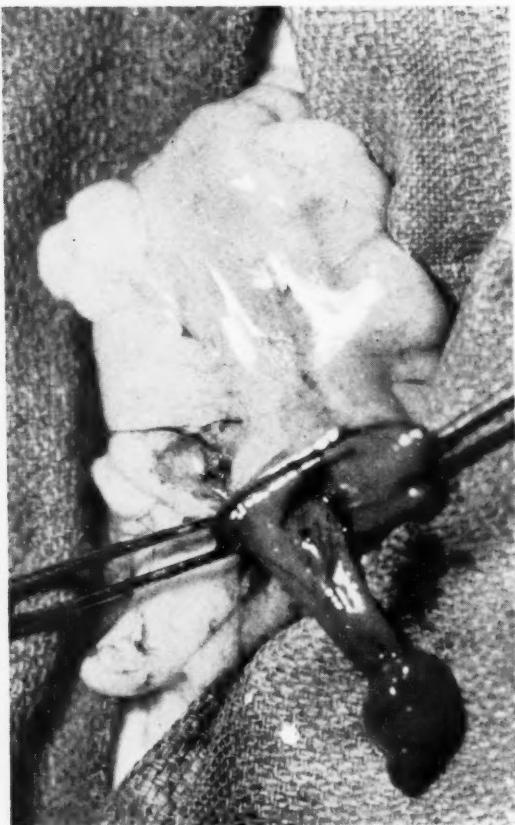


Case 2. Fig. 2A.



Case 2. Fig. 2C.

kilovolts up till 1951, since which time he has been using 120 kilovolts. (Fig. 2-A.) Another way of obtaining good mucosal visualization in filled-colon films is by the primary double-contrast method advocated by Moreton, Cooper and Foegelle<sup>26</sup>. These workers, using a "Y" tube provided for independent injection



Case 2. Fig. 2D.

#### Case 2. Fig. 2.

Mrs. M. M. Age 53 — Malignant Polyp.

This patient had passed bright blood by bowel on three occasions during the past five months. Radiological examination showed a polyp some 2 cms. in diameter in the upper sigmoid. At operation a polyp, as described, was found. Sigmoidoscopic examination of descending colon and lower sigmoid at operation revealed no further polypi. The pathological report was "malignant polyp".

A. The polyp is shown in the filled-colon film by heavy-penetration technique.

B. In post-evacuation film the polyp stands out as a globular shadow in the tightly contracted colon. The degree of contraction due to tannic acid reasonably excludes the presence of other polypi.

C. Polyp is again outlined clearly by secondary double contrast.

D. Shows the fresh post-operative specimen.

of barium suspension and air, obtain a double-contrast study at the original examination by tilting the table and using the force of gravity plus air pressure and manual palpation to manipulate the barium and air around to the caecum. Some practice is required to attain proficiency with this method but with a little patience one can obtain good double-contrast films in this way. (Fig. 2-A.)

Visualization of the entire mucosa of the large bowel in contracted state is facilitated by the addition of tannic acid to the enema fluid, as reported by Hamilton<sup>14</sup> and later by Christie, Coe, Hampton and Wyatt<sup>15</sup>. The latter authors advocate one gram of fluffy tannic acid to 100 cu. cms. of enema fluid. We found this mixture to be followed in a number of cases by rather severe cramps on evacuation of the enema and some patients fainted at stool. We therefore have reduced the amount of tannic acid to  $\frac{1}{2}$  gr. to 100 cu. cms. of enema fluid and feel that we are obtaining just as good post-evacuation films. In elderly or debilitated patients we now omit the tannic acid. (Fig. 2-B.)

In recent years many brands of prepared or special barium sulphates have become available. They feature two principles either individually or combined. These are more finely particulated barium and the addition of a colloidal agent. Considerable experience will be required to establish the degree of advantage of these new barium preparations, though they do seem to have some advantage in adherence to bowel wall, so desirable in double-contrast examinations.

Improvements in apparatus have contributed very materially to the ease of obtaining uniformly better films of the colon and we have found high kilovoltages up to 120 K.V. using a 16:1 grid has improved our film quality very materially. Photo-timing has proven to be of inestimable value in maintaining uniformity of film density.

We have lately been combining over-penetration technique, using 120 kilovolts, with primary double contrast, using 32% barium sulphate in water and air as a primary procedure. We add  $\frac{1}{2}$  gr. of tannic acid to 100 cu. cms of enema fluid which also contains Agar-gel. By using primary double contrast heavier barium suspension may be used, as it is later diluted with the air, and is better visualized fluoroscopically. The customary spot films of rectum in lateral projection and of the uncoiled sigmoid, splenic and hepatic flexures are made during fluoroscopy followed by full-size antero-posterior and postero-anterior

films. The barium and air shift their positions between the antero-posterior and postero-anterior films and in this way good double-contrast films of all parts of the bowel are usually obtained. (Fig. 8-A) With a little practice it is possible to fill the entire colon as rapidly, if not more rapidly, with double-contrast enema than with barium alone, and usually with less distress to the patient. A possible explanation of this latter observation is that the air introduced is compressible and so causes less reactive spasm. Every effort must be made to establish definitely that the caput coli has been filled. Visualization of the terminal loop of ileum or the appendix is essential to a complete colon examination. If the caecum cannot be positively identified by barium enema and if any question of disease in the caecum exists, it is necessary to give the patient a barium meal and to follow it until the terminal ileum and the caecum are positively identified. We have used this method of primary double contrast now in over five hundred colon examinations without undue reactions and with, we feel, improved results.

### Polypi

Small polypoid lesions have been the subject of intensive study in recent years and attempts to visualize and locate them with certainty have been responsible for most of the improvement in radiological investigation of the colon. With present radiological technique it should be possible to demonstrate lesions a centimeter or larger in size. Few lesions smaller than 1 cm. in diameter are likely to be shown by X-ray examination. In all cases of small or doubtful filling defects a repeat examination should be done to prove that there is indeed a lesion present. Polypi may be single or multiple, small or large, sessile or pedunculated, benign or malignant. A simple classification is polyp, single or few in number; polyposis, or as it is usually termed, multiple polyposis, and pseudopolypi. The first two groups are true tumours, adenomas or papillomas, the third group are islands or projections of normal or atrophic colonic mucosa pinched up between ulcers or scar tissue. True polyps or adenomas are somewhat more common in males than in females. More than one polyp are frequently present. The rectum and the sigmoid are the commonest sites. In a series of 7,000 autopsies Lawrence<sup>19</sup> found 166 cases of colonic polypi. The sex incidence was 3 males to 2 females. Over half of his cases showed multiplicity of lesions but most of these cases showed localized distribution of the polypi.

Scarborough and Klein<sup>31</sup> in an excellent analysis of 458 cases in whom original investigation revealed evidence of presumably benign polypoid lesions, found the disease to be 10% more common in males than in females. Sixty-four percent had a single polyp, 31% had 2 to 10 polyps and 5% had diffuse or multiple polyposis. A more recent study of 1843 autopsies by Swinton and Haug<sup>35</sup> showed 130, or 7%, to have polyps in the colon or rectum. In fifty-eight percent solitary polyp was found and in 42% 2 or more polyps were present. The relatively high percentage of cases in which more than one polyp is present indicates that where one polyp is found, either by sigmoidoscopic or radiological examination, every effort must be made to prove or exclude the presence of other polypi.

The relationship of benign polypi to cancer of the colon has been the subject of much investigation, which has not, however, resulted in uniformity of conclusion. The benign polyp has been regarded by many as a pre-cancer lesion. The terms malignant polyp and carcinoma in situ introduced by the pathologists have not helped to clarify the picture. This latter group of cases show evidence of local malignancy but are not invasive and tend to run a benign course. Thus McIntyre and Anderson<sup>24</sup> found no evidence of true malignancy or metastasis in pedunculated colonic or rectal polypi in specimens of the Department of Surgical Pathology of the Toronto General Hospital over a ten-year period, even though over half of these cases had been reported as malignant polypi. On the other hand, Hultborn<sup>18</sup> in an analysis of colonic and rectal lesions seen at the Karolinska Sjukhuset, in a series of 105 polypi, found 7 cases later proven to be cancers, which could not be distinguished from benign polypi when first visualized radiologically. The flat or sessile lesion is more likely to be malignant than the pedunculated polyp. It is not always possible, however, to be certain whether a small lesion seen radiologically is or is not pedunculated. For the above reasons it seems obvious that our search for smaller colonic lesions must continue with increased diligence and that the safe polypoid lesion of the colon is the one which has been removed and which is proven to be benign. (Cases 2 and 3, Fig. 2 and 3.)

There is a great tendency for colonic polypi to haemorrhage, whether they are pedunculated or sessile. The haemorrhage may be massive and alarming or small and recurrent, or it may be manifested by the presence of occult blood in the stool. Intestinal haemorrhage should always raise the question of

colonic polyp or polypi as well as of cancer, particularly in younger individuals.

Polyposis or adenomatosis is an uncommon condition in which the whole colon from caecum to rectum is studded with small or medium-sized polypi which tend to show uniformity in size. It is sometimes referred to as multiple polyposis, the double plural being used to stress the large number of the polypi present. The disease tends to occur in young individuals. McKenney<sup>25</sup> has adduced considerable evidence to show that there is a heredo-familial tendency in polyposis. The high incidence of carcinoma in polyposis is well established.



Case 3. Fig. 3A.

#### Mrs. A. G. Age 38 — Malignant Polyp of Colon.

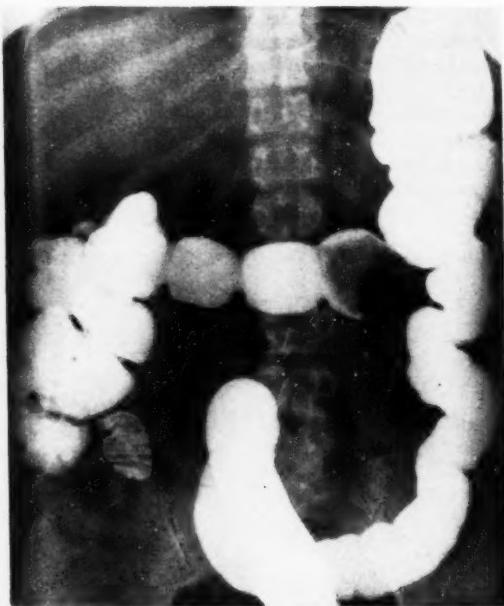
The patient had crampy abdominal pain with constipation for two weeks, though she had daily bowel movements during this time, including the day of admission. During the forenoon of the day of admission her pain became much more severe and she began to pass blood. On radiological examination, "A", obstruction to the enema flow was met in the distal transverse colon. The barium flowing partially around a globular lesion which suggested intussusception possibly due to an extra-mucosal, intra-mural tumour. At operation there was found a large polypoid lesion with intussusception. The polyp was the size of a small orange. Pathological report was "malignant polyp". Note its similarity to the lipoma shown in Fig. 4. "B" shows the resected specimen, the colon split longitudinally and the polyp cut transversely.



Case 3. Fig. 3B.

As well as mucosal tumours the large bowel is not infrequently the site of intra-mural extra-mucosal tumours of mesoblastic origin and fibroma, lipoma or myoma may be found. These tumours are frequently larger than the average adenomatous polyp and tend to be solitary. They seldom develop a pedicle and have greater tendency to intussusception. The differentiation from solitary polyp is, however, not infrequently impossible prior to microscopic section. (Case 4.)

A number of other conditions may produce globular or hemi-globular defects which may be confused with polyps and polypoid tumours. As shown in a recent excellent article by Fleischner and Bernstein,<sup>26</sup> the normal ileo-caecal valve varies widely in its contours and its relative indentation of the caecum but it is seldom confused with tumour. In 1943 Golden<sup>13</sup> reported a case of "apparent hypertrophy of the structures forming the ileo-caecal valve, associated with oedema of the mucosa, and producing a Roentgen defect simulating ileo-caecal intussusception". He also reported "a similar but much smaller defect produced at the ileo-caecal junction by oedema of the valve lips in a case of regional enteritis of the terminal ileum".



Case 4. Fig. 4.

**Mrs. R. E. Age 43 — Lipoma of Colon.**

Seven weeks prior to radiological examination this patient developed sudden epigastric pain which subsided slowly but later recurred on a number of occasions. She has noted that her stools have been black and tarry on occasions for the past two months. The filled-colon film shows a large globular filling defect with a layer of barium extending into the crevice between the tumour and the colonic wall. This finding is highly suggestive of extra-mucosal, intra-mural tumour. On resection it proved to be a lipoma. Note resemblance to polyp in Case 3.

In 1950 Hawley and Mithaufer<sup>15</sup> found 4 cases of enlarged ileo-caecal valve or prolapsed mucosa in the literature and added two of their own. They reported that the cases in the literature had hypertrophy of the valve as well. Their cases had no hypertrophy of the ileo-caecal valve but the appearance of the prolapsed mucosa resembled polypoid tumours. Both were explored and prolapsed mucosa only found. One had occult blood in the stools; the other had not. Blood in the stools, either gross or occult, has not been a frequent finding in the reported cases. More recently Rigler and Lasser<sup>30</sup> have reported a case of ileal prolapse involving chiefly the lower lip of the ileo-caecal valve in which the oedematous mucosa was visualized first as a filling defect in the extreme terminal ileum and was later visualized as prolapsed ileal mucosa in the caecum. Resection showed prolapsed ileal mucosa. In 1943 a case of sub-

mucous lipoma of the ileo-caecal valve with chronic intussusception was reported at a staff meeting of the Massachusetts General Hospital.<sup>22</sup> A large globular caecal filling defect in the region of the ileo-caecal valve was present. More recently Hinkel<sup>16</sup> has reported a series of 23 cases of caecal defects due to enlarged ileo-caecal valve or to prolapsed mucosa. Two of his cases were explored surgically and no tumour found.

We have only one case of prolapsed mucosa which has been explored. (Case 5 Fig. 5.) Since this condition has been brought to our attention we have found 12 other cases which we believe to be prolapsed ileal mucosa. The condition is seen more often or to better ad-



Case 5. Fig. 5.

**Mrs. S. McK. Age 62 — Cancer of Colon and Ileal Prolapse.**

This patient had passed bright red blood by bowel on four occasions in the past four months. Radiological examination showed a polypoid defect in the heavy-penetrated filled-colon film and in the post-evacuation film. In the post-evacuation film a polyp-like defect is present in the caecum at the site of the ileo-caecal valve and which we erroneously interpreted as a polyp. Note the blob of barium lying in the depression in the everted ileal mucosa. At operation the cancer of the descending colon was removed by primary resection. No mass could be felt in the caecum. The caecum was opened and prolapsed mucosa only found.

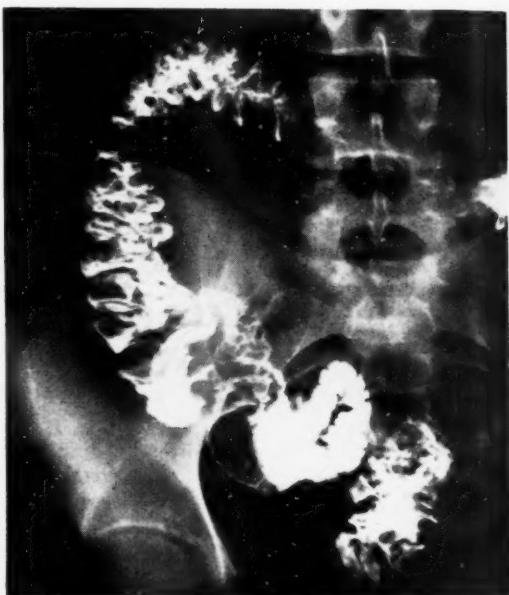
vantage in the post-evacuation examination. Only one of our cases has had blood in the stool. In no case was a mass palpable and recheck examinations have shown no enlargement of the prolapse. In fact, in two cases we have been unable to demonstrate the defect at a second examination. We have wondered on occasion whether the tannic acid in our enema fluid has been responsible for the prolapse by causing strong contraction of muscle of terminal ileum. While polypoid tumours may occur very close to the ileo-caecal valve, the location of a smooth globular tumour at the ileo-caecal valve should raise the question of prolapse. In ileal prolapse the barium frequently outlines the star-shaped pattern of the head of the prolapsed mucosa. Every effort should be made to fill the terminal ileum, as it will lead into the centre of the herniated mucosa and establish the location of the globular defect.

Appendiceal lesions apart from abscess are seldom confused with carcinoma or with polyp. However, in 1940 Weber and Good<sup>10</sup> called attention to the possible confusion of an inverted appendiceal stump with a small caecal polyp. The hemi-globular defect is small. It is at the appendiceal site and the history of appendectomy and absence of bleeding is usually sufficient to establish the diagnosis.



Case 6. Fig. 6A.

In 1941 Skarby<sup>11</sup> described the radiological findings in appendix invagination in which appendiceal mucosa or entire appendiceal wall protruding into the caecum causes a polypoid defect. We recently have observed three such cases, one of which is shown as Case No. 6, Fig. 6. In one case appendix invagination and ileal prolapse were co-existent.



Case 6. Fig. 6B.

## Case 6. Fig. 6.

## Miss B. G. Age 25 — Appendix Invagination.

This young woman had recurring right lower quadrant pain which suggested appendiceal disease. The first barium enema "A" shows polyp-like deformity in the caput coli at the appendiceal site. Recheck examination "B" shows appendix filled and presenting everted mucosal margins causing the defect. At operation a diseased appendix was removed and there was found protrusion of oedematous appendiceal mucosa causing the globular defect.

Mucocele of the appendix described by Akerlund<sup>1</sup> in 1936 and by Euphrat<sup>6</sup> in 1947 is not usually confused with polyp. It usually deforms the caecum by extrinsic pressure either medially or laterally. When small, however, a mucocele of the appendix may produce a globular defect of the caput coli resembling a solitary polyp. (Case 7 Fig. 7.)

Carcinoid tumours of the appendix are seldom diagnosed by x-ray or even considered in the differential radiological diagnosis. We

must bear in mind, however, that the carcinoid tumour is not limited to the appendix but may arise anywhere in the intestinal tract and may cause a polypoid tumour of the colon. Thus Foreman<sup>16</sup> found 5 cases of carcinoid of the rectum in a series of 38 cases and Horn<sup>17</sup> found 13 cases in the large bowel in a series of 36 cases. The large bowel lesions in Horn's series included 5 in caecum and ascending colon, 2 in transverse colon, 6 in the rectum, and 2 apparently arising in the ileo-caecal valve. Recent literature stresses that these tumours are not benign as was originally thought but are locally invasive and there are many reported instances of death due to distant metastasis. We recently have had a case of carcinoid of the transverse colon which was indistinguishable radiologically and at operation from an adenomatous polyp. (Case 8 Fig. 8.)



Case 7. Fig. 7.

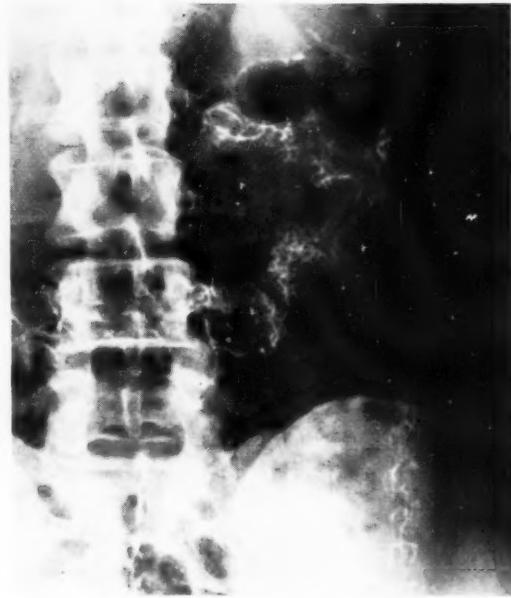
Case 7. Fig. 7. .

**Mr. F. S. C. — Mucocele of Retro-Caecal Appendix.**

This man had had recurring attacks of right lower quadrant pain for five years. Radiological examination revealed a smooth, globular filling defect in the caecum with a vaguely palpable, tender mass. There had been no rectal bleeding or change in bowel habit. The possibility of mucocele of the appendix was suggested in the differential diagnosis from polyp or polypoid carcinoma. Operation revealed a mucocele in a retro-caecal appendix corresponding accurately to the radiological finding.



Case 8. Fig. 8A.



Case 8. Fig. 8B.

Case 8. Fig. 8.

**Mrs. B. F. Age 55 — Carcinoid Tumour of Transverse Colon.**

This woman had had her left rectus abdominus muscle resected five years previously for a desmoid

tumour. On routine abdominal examination her surgeon felt a small mass in the left upper abdomen. The patient was asymptomatic. Colon examination revealed a globular tumour in the transverse colon. Resection and primary anastomosis was performed. There were no visible metastases at operation. The pathological findings were those of carcinoid tumour. We think these films illustrate again the value of heavy-penetration double-contrast technique — "A", and also of tannic acid for post-evacuation mucosal study — "B".

An infrequent cause of a globular defect simulating polyp or polypoid tumour is an impacted or fixed faecalith. That a faecalith should or could become impacted, or fixed so that it is not passed along by peristalsis, is difficult to understand, but we recently encountered this condition. (Case 9 Fig. 9.)



Case 9. Fig. 9A.

Case 9. Fig. 9.

**Mrs. E. C. Age 58 — Intestinal Obstruction  
Due to Faecalith.**

This patient had alternating constipation and diarrhoea for one year. There had been no haemorrhage but occult blood was present in the stool. There had been no loss in weight. She was admitted with large bowel obstruction. Her first examination showed only obstruction to the enema flow in the mid-sigmoid. Her obstruction slowly subsided and barium enema, two weeks later, revealed a large polypoid filling defect in the sigmoid. This was thought radiologically to be a large polypoid tumour, probably carcinoma. At operation it proved to be a large faecalith.

"A" shows the filling defect in the filled-enema film.

"B" shows the lesion in the post-evacuation film.



Case 9. Fig. 9B.

**Ulcerative Colitis**

Chronic ulcerative colitis is characteristically a disease of young adults, though older age groups are by no means immune. The disease which is ulcerative in earlier stages heals by scar tissue in the mucosa, sub-mucosa and muscularis. Epithelial regeneration occurs in the mucosa with the frequent formation of pseudopolypi by mucosa being pinched up by scar tissue. It is the relationship of these pseudopolypi to carcinoma which leads to the inclusion of ulcerative colitis at this time. Since Yeomans<sup>11</sup> in 1927 reported a case of carcinoma arising in chronic ulcerative colitis this finding has been frequently observed. Thus, Counsell and Dukes<sup>5</sup> found 7 cases of cancer in 63 cases of chronic ulcerative colitis treated surgically at St. Mark's Hospital, London, an incidence of 11%. Of 11 cases who survived their ulcerative colitis for ten years, 5 ultimately died of cancer of the colon. That chronic ulcerative colitis is a pre-cancer lesion is now widely believed, though opinion is not in entire agreement as to the mode of origin of cancer, as to whether the disease arises directly in the chronic inflammatory mucosa, or in the pseudopolypi, or in true adenomas which in turn have developed in the pseudopolypoid mucosa. Sloan, Bargen and Baggensstoss<sup>14</sup> in an analysis of 2,000 cases seen at the Mayo Clinic over a twenty-year period found benign polypi to be the commonest complication of chronic ulcerative colitis. They occurred more commonly

in patients with disease... were... flamm... and t... triple follow... group... develope... Turn... cases whom... There... that c... litis i... metas... repor... cance... no ev... arose... Most... though... 10, F...

Mr... eleven... logica... chara... transv... colitis... and ri... was p...

in patients who had had a severe form of the disease. Biopsies of the polypi in 52 instances were reported as inflammatory in 65%, inflammatory with adenomatous change in 15% and true adenoma in 20%. Polypi were multiple in 75% of those who had them. Their follow-up indicated that 5% of their total group of cases of chronic ulcerative colitis developed carcinoma of the rectum or colon. Turnbull and Brown<sup>37</sup> recently reported two cases of carcinoma in ulcerative colitis in whom no polypi or pseudopolypi were present. There is general agreement in the literature that cancer arising in chronic ulcerative colitis is likely to be a rapidly-growing, early-metastasising, highly malignant tumour, and reported cures are rare. In our own cases of cancer in chronic ulcerative colitis there is no evidence to suggest that these cancers arose in polypi or in pseudopolypoid mucosa. Most of our cases were quite rapidly fatal, though we have one notable exception. (Case 10, Fig. 10.)



Case 10. Fig. 10.

Mrs. J. B. Age 27 — Chronic Ulcerative Colitis with Carcinoma.

This patient has had chronic ulcerative colitis for eleven years with blood and mucus in stool. Radiological examination on August 30th, 1950, showed characteristic findings of carcinoma in the proximal transverse colon superimposed on chronic ulcerative colitis. In December, 1950, she was operated upon and right hemicolectomy with ileocolic anastomosis was performed. The diagnoses of ulcerative colitis and carcinoma were proven microscopically. Since

that time she has remained well, has gone through a normal pregnancy and in November, 1952, was alive and well, had maintained her weight and had only some slight diarrhoea.

### Conclusions

1. The radiologist cannot assume responsibility for the diagnosis of lesions in the rectum. The lower sigmoid is frequently difficult to visualize satisfactorily radiologically. The high incidence of polypi and of carcinoma in these regions necessitates the combined use of sigmoidoscopic and radiological examinations to prove or exclude disease of the large bowel.

2. Every patient who gives a story of rectal bleeding or of persistent or recurrent change of bowel habit should be investigated by sigmoidoscopic and radiological means. Haemorrhoids should not be accepted as an explanation of rectal bleeding until more serious causes of bleeding have been excluded.

3. Polypi are a common cause of rectal bleeding. While many of these are benign and many are of local or low-grade malignancy, there is no definite assurance that a benign polyp may not become malignant, or that a malignant polyp or carcinoma in situ may not later become a frank cancer. We as radiologists, therefore, must continue to improve our methods of examination of the colon by all possible means in an effort to discover a higher percentage of small colonic lesions.

4. Some ways in which radiological examination of the colon may be improved have been suggested.

5. Some lesions which may be confused with polypi and small polypoid cancers have been presented and their differential diagnosis discussed.

### Acknowledgements:

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OSTEITIS CONDENSANS ILII\*

JOSEPH BLOOM, M.D.

X-ray Department, Jewish General Hospital

Montreal

Osteitis Condensans Ilii is characterized by an area of increased bone condensation at the lower end of the auricular portion of the ilium adjacent to the sacroiliac joint. The bone involved has a somewhat "frosted" appearance. It does not involve the joint, nor the sacrum and gradually fades laterally into the ilium. The literature on this subject is scanty and the two cases which we are to report responded well to deep roentgen therapy, where more conservative measures had previously failed.

In 1926 Sicard, Gally and Haguenauf<sup>1</sup> in France first noted and described the roentgenographic appearance of Osteitis Condensans Ilii. They reported 5 cases. Two years later Barsony & Polgar,<sup>2</sup> recognizing its sclerotic nature, named it "Osteitis Condensans Ilii" and described it as a sclerosing bone disease readily demonstrable by X-ray and confined to the os ilii. They presented 15 cases which came to their attention in a period of 1½ years. In 1932 osteitis condensans ilii was again mentioned at a gynecological congress in Göttingen where Fritz Berent<sup>3</sup> presented 3 cases which had some injury prior to or during delivery as a result of premature rupture of the membranes, the use of high forceps etc., and erroneously concluded that this disease affected only multiparous women.

In 1936 Rendich & Shapiro<sup>4</sup> presented 12 cases of which 3 were males, one of whom was operated on to stabilize the sacroiliac joint. During this operation a section of the sclerosed bone was removed for biopsy, the details of which will be considered later.

In October 1950 Shipp & Haggart<sup>5</sup> of Boston presented 100 cases of osteitis condensans ilii all of which were in adult white females of whom 78 had borne children, and of these, 48 dated the onset of their symptoms to pregnancy. In 6 of these patients serial roentgenograms showed a diminution in the

degree of sclerosis during the course of conservative therapy. Two of their hundred cases failed to respond to the more conservative measures. The degree of pain and disability in them were such as to warrant surgical fusion of the sacroiliac joints. This afforded complete relief in both instances.

Routine antero-posterior, lateral and semi-oblique views of the lumbosacral spine are necessary for proper visualization of the sacroiliac bones, joints and sacral foramina in their entirety. It is necessary to exclude pathological changes within the sacroiliac joints, before the diagnosis of osteitis condensans ilii can be entertained. The auricular portion of the ilium, which is most commonly involved, lies behind the anterior margin of the joint so that, in the ordinary antero-posterior views of this region, pathological changes within this portion of the ilium superimposed or projected on a normal sacroiliac joint or sacrum may be misleading and give the false impression of involvement of the sacrum. Semi-oblique views of the sacroiliac joints, however, rule out that possibility. Sepia toning of the roentgenogram by controlling the fixing process of the film in the dark room helps to accentuate osteitis condensans lesions in bone, showing them up to better advantage. This procedure should be used when the diagnosis is in doubt. Underdevelopment of a purposely over-exposed roentgenogram will also help to accentuate these lesions on the x-ray film.

Osteitis condensans ilii roentgenographically is characterized by a dense bony sclerosis with obliteration of the trabeculae of the auricular portion of the ilium adjacent to the sacroiliac articulation. It may be limited to a small area near the most inferior portion of the joint or it may involve the entire extent of the ilium as it adjoins the sacrum. The area may be sharply demarcated from the surrounding bone or it may gradually merge with it. The usual antero-posterior view gives one the impression that the involved area has been under-exposed and does not show trabeculae or other bony structures. On a purposely over-exposed film, however, the

\*Presented at Annual Meeting of the Canadian Association of Radiologists, Toronto, Ontario, January 28th-30th, 1953.

bony trabeculae are found to be thickened and irregular. The lacunar spaces appear filled with more calcium than usual and the entire involved zone has a uniformly opaque "frosted" appearance. The sclerosis ends very abruptly at the sacroiliac joint medially and merges into the normal iliac bone laterally. The sacroiliac joint and sacrum never show any evidence of involvement. Although this lesion appears to have its origin near the inferior portion of the joint, it may extend upwards to involve a considerable portion of the iliac bone, almost reaching its crest, and involving the entire ilium adjacent to the sacroiliac joint.

Rendich and Shapiro<sup>4</sup> stress the relationship between the local blood supply of the ilium and the extent of involvement with the condensing osteitis. A nutrient foramen occurs with great regularity in the lower portion of the ilium adjacent to the sacroiliac joint, which is the common site of the osteitis condensans. Occasionally two or three nutrient foramina are similarly situated though higher up towards the iliac crest and may explain the more extensive involvement of the ilium mentioned above.

Patients affected with osteitis condensans ili<sup>i</sup> usually complain of chronic low-back pain radiating to one or both gluteal regions. The pain is never sciatic in distribution. The pain is not aggravated by coughing or straining but is almost always relieved by bed rest. Night pain is significantly absent. The pain gradually increases in severity to become more or less continuous and is occasionally severe enough to be incapacitating. Many date the onset of their symptoms to the last trimester of pregnancy or immediately following delivery, while in some instances, the pain appears following rapid gain in weight, excessive physical fatigue or other debilitating factors. It is aggravated by bending and patients often complain of their inability to lace their shoes. The disease is largely, though not entirely, confined to white females of the child bearing period and have been reported anywhere from 19 to 45 years of age. Most cases are entirely asymptomatic and their discovery incidental to examinations of systems other than the skeletal. The roentgenographic appearance bears no relationship to the severity of symptoms.

On examination, these patients reveal an increase in the normal lumbar curve associated, in the more severe cases, with spasm of the erector spinae muscles. The usual tests

for sacroiliac disease including the alternate compression and separation of the iliac crests and "straight leg raising" are uniformly negative. Laboratory findings including the blood sedimentation rate, blood calcium, phosphorus and phosphatase are all normal.

Berent<sup>3</sup> is of the opinion that osteitis condensans ili<sup>i</sup> is the result of periosteal ligamentous and capsular trauma due to gravidity and labour, which cause an alteration in the blood supply of the ilium adjacent to the sacroiliac joint. This fails, however, to account for the occurrence of this disease in males and nulliparous females in which the etiology is still obscure.

As far as the pathology of this lesion is concerned one can do no better than quote verbatim the report of Dr. William Hala<sup>4</sup> on a biopsy of the involved bone taken by Rendich & Shapiro in 1936. "There is marked condensation of the osseous tissue with obliteration of the evident former lacunae. There appear to be no osteolytic or osteoclastic changes in the bone and neither is there any evidence of overactivity of the osteoclasts or osteoblasts. In fact, these cells are more or less conspicuous by their absence. The marrow spaces contain an usual number of myelocytic and plasma types of cells. The significance of the plasma cells is undetermined. In general the lesion appears to be of an osteitis condensans type."

"It is apparently independent of an inflammatory or other etiology as far as can be ascertained from the histology of the specimen. Occasionally in the condensed bone there appear to be depositions of lime salts which occur more or less in irregular linear areas but more or less parallel to the lamellae of the bone". Bacteriological studies using both aerobic and anaerobic techniques gave negative results.

Radiologists frequently observe and describe isolated areas of increased bone condensation within various parts of the skeletal system, e.g., the pelvis, femur, calcaneus or humerus, without further comment. Whether osteitis condensans ili<sup>i</sup> bears some relation to the latter which may be embolic manifestations of the same process is something worthy of our consideration.

Osteitis condensans ili<sup>i</sup> has to be differentiated from Marie Struempell arthritis, which, in contrast to the former, usually occurs in

males and in its early stages involves the sacroiliac joints. An elevated sedimentation rate and positive sacroiliac tests are present in even very early Marie Struempell arthritis, but persistently absent in osteitis condensans ilii. Furthermore, the osteitis condensans is localized to the ilium and does not progress to involve the entire spine as is the case with an arthritis of the Marie Struempell type. Sacroiliac epiphysitis, Paget's disease and degenerative arthritis can be excluded on the basis of age incidence and roentgenographic appearance.

#### Case Reports:

Our first case, a young unmarried female of about 28 years of age, had suffered "low back" pain for the past 2 years. She had been seen by many doctors, had attended many reputable clinics where all modes of physiotherapy were carried out without effect. She finally had to take to bed where she had some measure of relief while flat on her back on a "boarded" mattress. On later assuming the erect posture, her pain again returned and she finally consented to have x-ray therapy in spite of the sterility which would follow and

First Case — 1.



First Case Treated

1.—A young unmarried female, 28 years old—showing osteitis condensans ilii most marked on the left side (before treatment).

which was fully explained to her. She received a total of 1600 r measured in air given through two portals with 2 Cu and 1 AL fil-

First Case — 2.



2.—Same case 6 months' later following physiotherapy (Short-wave diathermy treatments etc.). There has been an appreciable increase in the amount of osteitis condensans ilii on the left side.

First Case — 3.



3.—Same case 18 months following roentgentherapy showing a diminution in the amount of the osteitis condensans with partial restoration of the normal bony architecture of the iliac bone on the left side.

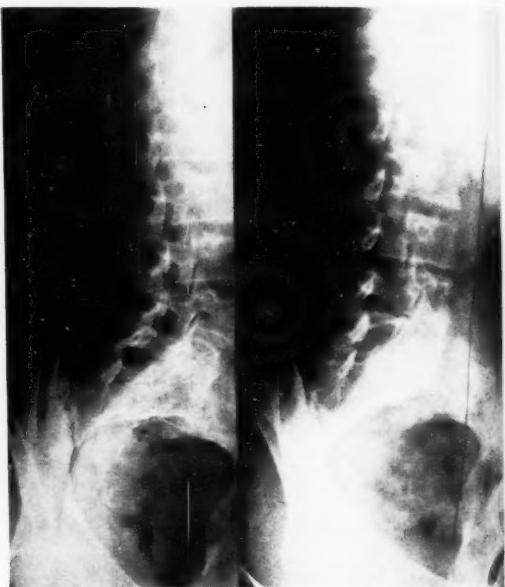
tration. She felt quite relieved after the fourth treatment and continued so up to date. X-rays of her pelvis about two years later showed a definite diminution in the amount of sclerosis. Her pain has been completely relieved and she has been able to continue with her previous work as a waitress. Her periods were now beginning to reappear and she states that other menopausal symptoms such as flushes etc., were negligible.

two months later—showed no appreciable diminution of the osteitis although symptomatically he felt much improved. This case will be further followed roentgenographically and we hope at some future date to be able to report a diminution in the amount of sclerosis, much the same as in our first case.

Since the writing of this paper, 3 other cases — 2 males and 1 female — have been similarly treated with equally good results.



Second Case — 1.



Second Case — 2.

A young male — 40 years old showing osteitis condensans ilii involving both iliac bones but not affecting the sacroiliac or apophyseal joints.

### Second Case Treated with Roentgentherapy

The second case is that of a young man age 40, who complained of "low back" pain for about two years. His back was somewhat rigid and he found difficulty in carrying on with his work as a shoe salesman. He was seen by several orthopedic specialists, who, diagnosed very early Marie Struempell arthritis and treated him with diathermy, massage and exercise without affording relief. He finally had to take to bed where he remained for several weeks without much improvement. X-rays of his lumbar spine revealed typical findings of osteitis condensans involving both iliac bones, without involvement of the sacroiliac joints, apophyseal joints or any other region of his spine. His blood findings were essentially negative. He was given a series of x-ray treatments similar to our first case with equally good results. X-rays of his pelvis —



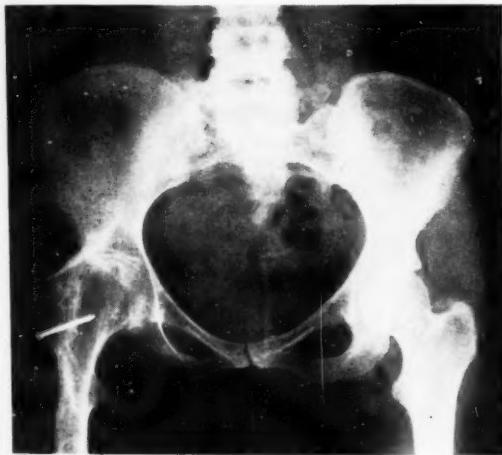
Third Case — 1.

**Third Case**  
1. — An over-exposed but under-developed radiograph of Osteitis Condensans Ilii in a male showing a small triangular area of osteitis condensans adjacent to the lower end of the right sacroiliac joint—about the site of the nutrient artery.



Third Case — 2.

2.—Same case with normal technique — the area of osteitis condensans ilii is obscured.



Two cases in which disease in one hip is associated with an area of osteitis condensans ilii within the iliac bone on the opposite side.



### Summary:

The literature on osteitis condensans ilii has been reviewed. Its pathogenesis and etiology are obscure. It is apparently a self-limited process or disease not falling into the category of any of our known bone diseases or affections. Roentgenographically it presents itself as a sclerotic bone lesion confined to the auricular portion of the iliac bone adjacent to the sacroiliac joint medially and to the nutrient foramina of the iliac bone laterally, almost suggesting bone infarction. That it is a reversible process has been shown roentgenographically in a number of cases including our own. Sepia toning and at times "over-exposure" of the roentgenogram help to show up these osteitis condensans bone lesions to better advantage. Although frequently responding to conservative physiotherapeutic measures, occasional cases require the more radical surgical procedure of fusion of the sacroiliac joints in order to restore patients so affected to a tolerable existence. Two such cases have been presented, showing good results with deep roentgen therapy which we feel should be tried before resorting to surgery.

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COBALT<sup>60</sup> TELETHERAPY

## Some Principles and Observations.\*

FRANK BATLEY, B.Sc., M.B., Ch.B., D.M.R.T.†

The Ontario Cancer Treatment and Research Foundation  
Hamilton, Ontario

The Journal of the Canadian Association of Radiologists has published a group of papers about radio-cobalt units during the past year. D. T. Green and R. F. Errington<sup>1</sup> have described the design of our London unit, and H. E. Johns<sup>2</sup> has described the Saskatchewan unit.

I. H. Smith<sup>3</sup> has discussed the possibilities of the new unit and shown comparative isodose diagrams with 250 K. V. X-rays. T. A. Watson<sup>4</sup> has described its advantages over a 3 Mev. X-ray apparatus, shown its use with rotation and also given comparative isodoses with 250 K. V. X-rays.

The purpose of this paper is to discuss some features we have found during further use of the new unit, which we hope will be of guidance to other centres where more of these units are being installed.

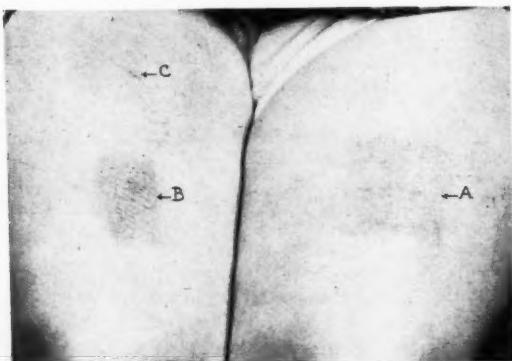


Figure 1

- Skin reactions from 1700 r in a single exposure.  
 (A) from 250 K.V. H.V.L. 3.5 Cu.  
 (B) Radio-cobalt with 6 mm of wax between the applicator and the skin.  
 (C) Radio-cobalt direct.

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†Formerly assistant radiotherapist to Dr. Ivan H. Smith at the Victoria Hospital, London, Ontario.

An important feature is that of the low skin reactions obtained, for with these radiations, the maximum dose lies at some 6 mm. below the skin, and it seems that this is sufficient to protect the surfaces from all but mild reactions. We have given 9500 r treating over six weeks on a single field 7 x 7 cm. and produced only a mild erythema!

Figure 1 is photograph showing a comparison between the skin reactions when using the radio-cobalt unit and the reaction from X-rays of H.V.L. 3.5 mm. of Cu. With equal doses of 1700 r given in a single exposure, the X-rays produced a deep erythema, moist in the centre (A), whereas the reaction from the radio-cobalt (C) could hardly be seen, being a mild erythema only. Insertion of 6 mm. of wax between the face of the cobalt applicator and the skin again gave a near-moist reaction (B). During this latter test the wax slipped to one side allowing the uninterrupted beam to treat half the area. This area of skin again showed a negligible reaction in contrast to the remainder of the field which showed the visible reaction.

These simple differences have a considerable influence on treatment doses, for although we may imagine that we think in terms of tumour doses, many treatments are actually designed with the skin reaction being the real limiting factor. For example, in the common post-operative treatment of carcinoma of the breast where the supraclavicular fossa and the axilla are irradiated by opposing fields, the limiting factors are the immediate and late skin reactions. Using the Cobalt unit these reactions are negligible for the same central dose previously obtained with 250 K. V., and perhaps therefore the central or tumour dose in the axilla can be raised, to better effect. I say perhaps, because at one time in Manchester, we used to avoid a high skin reaction in this type of treatment by using a pin-and-arc technique to beam-direct to the apex of the axilla. This treatment was abandoned because of the high incidence of brachial neuritis. But here there was another factor besides the high tumour dose given — that of a short overall time, the treatment

being given in a single day or over four days. It illustrates, however, that the absence of skin reaction can be a danger as well as an asset. We shall have to think more in terms of tumour dose than previously. It is quite easy to irradiate the whole of the pelvis by two opposing fields without any skin reaction, and yet produce considerable proctitis and cystitis, but measurement or calculation of the central dose correlates with these reactions and such estimations are necessary in every case.

In the irradiation of a Ewing's tumour of a limb the usual large field technique is limited by skin reaction. How much more dose can be safely given in its absence before tolerance of the bone and soft tissues is reached? This type of case is not common enough to allow of an answer yet. Before leaving this question of low skin reaction, there are also the many palliative treatments to consider. With these, our practice used to be to measure the area being treated and look at the skin tolerance graph to choose a dose which would give a moderate reaction. Now however, with these reduced reactions the dose can often be doubled, with a corresponding important improvement in the palliation.

As an illustration, let us consider the treatment of a radio-resistant tumour such as a malignant melanoma. I personally cannot see why we should expect a different biological response with the Cobalt radiations because they are almost monochromatic, than we would with radiations of many wave lengths. The primary beam produces electrons and these must, before they produce their total ionisation, give a broad spectrum of energies. There are occasional melanomata that do show some response to X-rays, and these are seen also with the Cobalt unit, but give no reason for treating a localized lesion other than by radical surgery. A common problem however, is the patient with inoperable secondary melanomatous nodes, and now that the skin reactions are so mild, it is possible to deliver a much higher dose to such nodes. Even with low radio-sensitivity a much greater resolution will thus be produced. It used to be taught that faced with such a situation, the response to radiotherapy was not sufficient to warrant palliative treatment since a severe skin reaction was necessary to give even slight resolution. Now we feel that in this and similar situations such a view must be revised. But as always with palliative treatments each case must be judged on its merits, taking into consideration whether the general condition of the patient warrants any palliative treatment other than morphine.

In the treatment of deep lesions such as carcinoma of the bronchus and bladder, the unit has the obvious advantages of an increased percentage depth dose. I. H. Smith<sup>3</sup> and T. A. Watson<sup>4</sup> have shown that in a beam-directed technique, much less dose is given to the intervening tissues than when using X-rays. This should have the effect of increasing the tolerance of the tumour bed and therefore allow of higher tumour doses, thus, we hope, increasing the number of cures.

But, in mobilizing our forces against our traditional and subtle enemy, the epidermoid carcinoma, we are faced as of old with the problem of the therapeutic ratio between the tolerance dose of the normal tissues surrounding the tumour and the tumour lethal dose. As the tumour increases in size its radio-resistance grows and the tolerance of the enlarging tumour bed, which has also to be irradiated, diminishes, so that the ratio narrows. In order to have any hope of success, we must treat a minimum of normal tissue other than the tumour. The radio-cobalt unit adapts easily to this type of attack, but we must use all the tricks of beam direction as with X-rays, and there are more tricks to be learned in this field of "plastic mathematics."

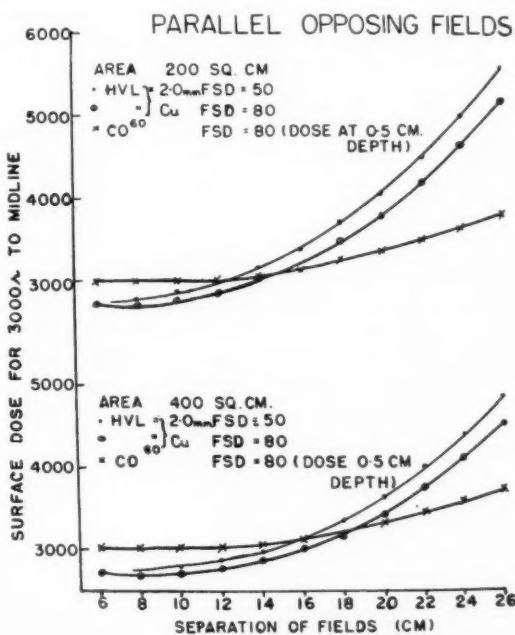


Figure 2  
Comparison of depth doses, for radio-cobalt and X-rays using parallel opposing fields.

Figure 2 shows a comparison of depth doses between X-rays of moderate voltage and radiations from radio-cobalt when using parallel opposing fields. The graphs show the summated surface doses necessary to give 3000 r at the midline for increasing separation of the fields. With the 400 sq. cm. field area there would, at first sight, seem to be no advantage in the radio-cobalt at separations up to 17 cms. but with greater separation the advantage increases and does so rapidly; therefore in treating an abdomen of 22 cm. thickness with the X-rays at 50 F.S.D., 4000 r would be given to the skin. This dose would be close enough to skin tolerance for a five-week over-all time to make one choose some other way of getting in the dose. The radio-cobalt unit would give a so-called surface dose of 3500 r in similar circumstances, but the major part of this total, being directly delivered from the field of that side, gives its maximum dose actually deep to the skin as mentioned above. In practice therefore the advantage is much greater than the graphs show.

Using smaller fields the advantage of the Cobalt is more obvious, as shown in the upper graph. This is because the percentage depth doses with the radio-cobalt are not helped much by the addition of scattered radiation. The addition of scatter is considerable for large fields with X-rays so that when the scattered radiation is less with the smaller fields, the percentage depth doses are reduced, whilst those for the Cobalt stay much as before.

When we irradiate mouth lesions there is always some bone in the field. Using Spiers<sup>5</sup> formulae, calculation of the relative absorption of energy in bone and soft tissues with different wave lengths of radiation, shows that 50% more energy is absorbed in a bone such as the mandible with 250 K.V. radiation, in comparison with Co<sup>60</sup> radiations. Thus, when carrying tissues close to tolerance, there is a much greater risk of bone necrosis with the X-radiation.

Turning to the question of nausea, we feel quite definitely that in treating the epigastrium nausea is much less, but certainly nausea still does occur and there is the usual variation with different patients. We still found it necessary to start with a low daily dose and rise gradually. We found using anterior and posterior fields to the epigastrium, that an initial dose of 120 r to each field was below the usual nausea threshold and the dose could then be increased by 10 r daily until an input

rate was reached which would achieve the required tumour dose in the prescribed overall time.

Mucosal reactions seem to be rather less, dose for dose, than with X-rays, so we estimated that 6000 r in three weeks produced a reaction that 5500 r would with 250 K.V. These were, of course, small volume treatments, as seen in cross-fire therapy to mouth neoplasms. Whether tumours will show a similarly reduced reaction is a worrying question.

There are some minor disadvantages. With our unit we are limited to rectangular fields, and in order to cut off corners to shield, say, a kidney or a growing epiphysis, lead of 3 cm. thickness is necessary to reduce the dose by 90%. Such masses of lead are difficult to handle, but certainly help immobilization. The output of 20 r min. at 100 cm. F.S.D. is somewhat low, but we decided to standardize at 80 F.S.D. to give an output of 30 r/min. The maximum size of field at 100 F.S.D. is 20 x 20 cm. But in bath treatments, we commonly need larger fields than these, and though by increasing the F.S.D. larger fields can be obtained, the output is then very low, and considerable penumbra appears. The penumbra is no worse than a similar arrangement would produce with X-radiation, but with the latter, sheets of lead rubber can be laid on the patient to limit the exact size of the field required. As mentioned above, however, great thicknesses of lead would be needed to shield Cobalt radiations.

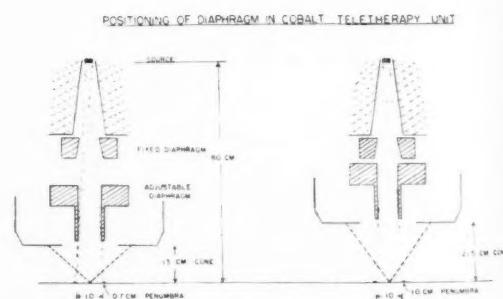


Figure 3

Diagram of the Radio-cobalt Unit showing the collimating devices and the use of the longer cone.

The nose of the unit sometimes makes some angles awkward or impossible, but this is only an exaggeration of a problem with which we are familiar. It is helpful to use the unit with the collimator set as for 70 F.S.D. and make

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special cones to give 80 F.S.D. As Figure 3 shows, this gives greater clearance from the nose though the penumbra is then slightly increased.

Finally, another word of warning, the use of the new Cobalt unit can be compared with the use of an expensive camera. A three hundred dollar camera has advantages over a cheaper model, but these can only be used effectively if one has also three hundred dollars' worth of dark room equipment. The picture that one could not take with a cheap camera, still needs hard work in the dark room to give a pleasing print, and without this dark room equipment, most of the advantages of the dearer camera are wasted. The dark room equipment necessary with a Cobalt unit are beam-direction devices, a mould-room, a physicist and his instrumentarium, and without these, most of its advantages are lost.

It is right that as many centres as possible should have these machines, but let the rest of the equipment be enough to make them worth while. There seems to be a real danger of thinking that the Cobalt unit by itself, is all that a radiotherapy centre needs, yet, if one had to choose between having a mould-room and a physics department or a Cobalt unit, one's choice could not with justice be for the Cobalt.

That pioneer of small-field beam-direction, Dr. J. L. Dobbie, speaking at a time when physicists were exploring the possibilities of 20 and 50 million volt X-rays, asked merely for 1.5 million volt machine, so as to test under optimum conditions the principles and

treatment methods he helped to popularise. Here is such an instrument—but the fact that we would choose the ancillary departments first is a measure of the value we put on their help.

## Acknowledgments:

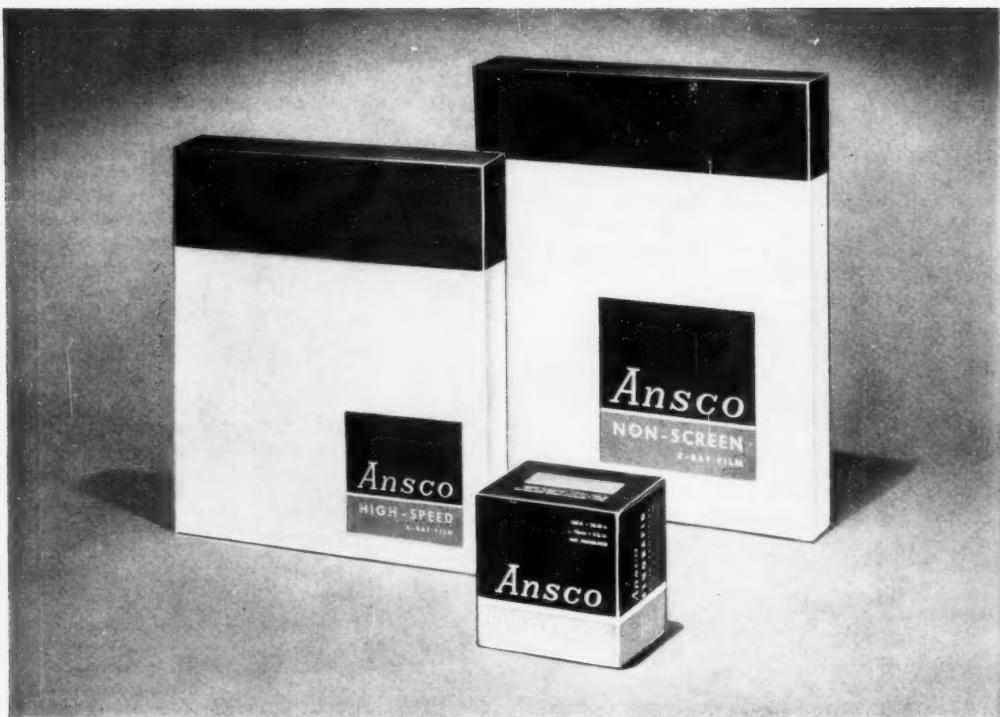
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